

THE MIAMI CONSERVANCY BULLETIN

OCTOBER 1919

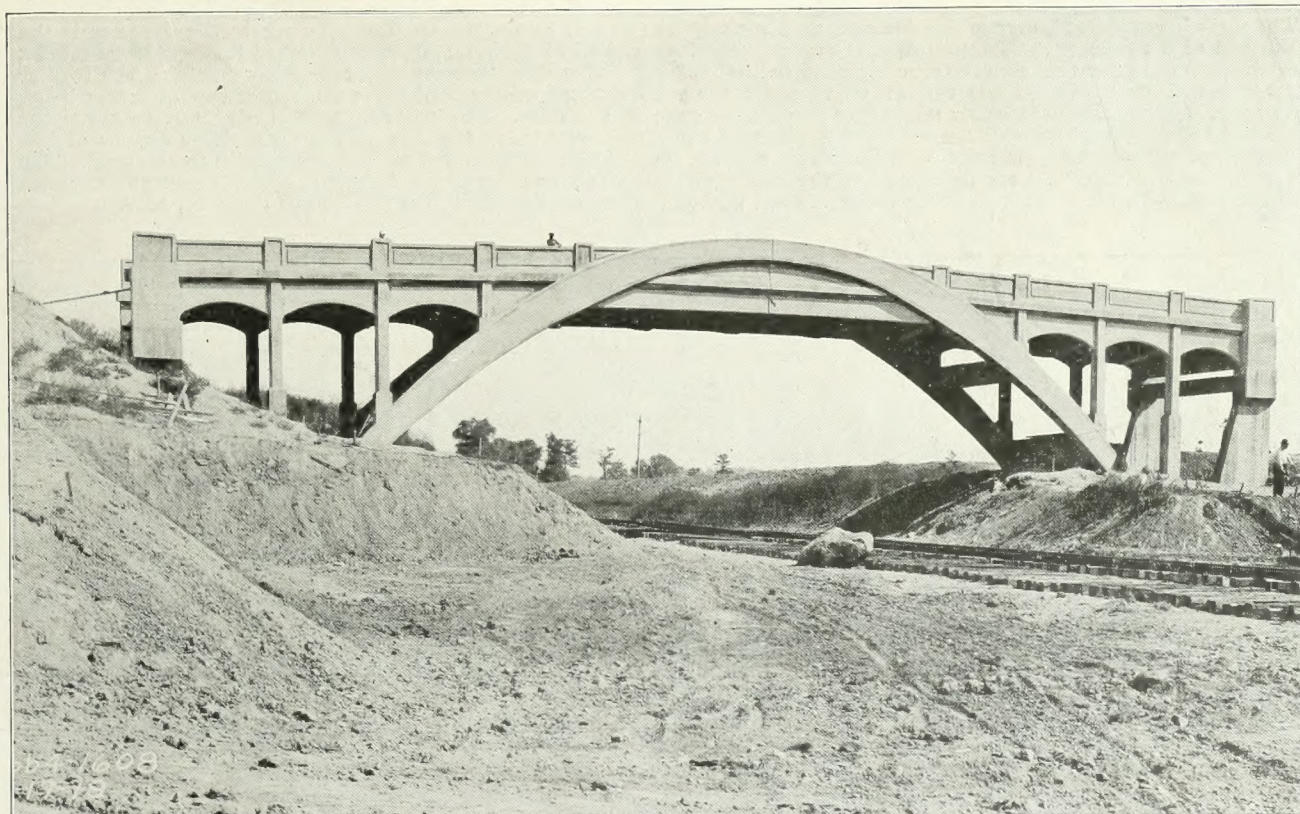


FIG. 28—BRIDGE OVER B. & O. R. R. RELOCATION AT TAYLORSVILLE DAM, SEPT. 17, 1919.

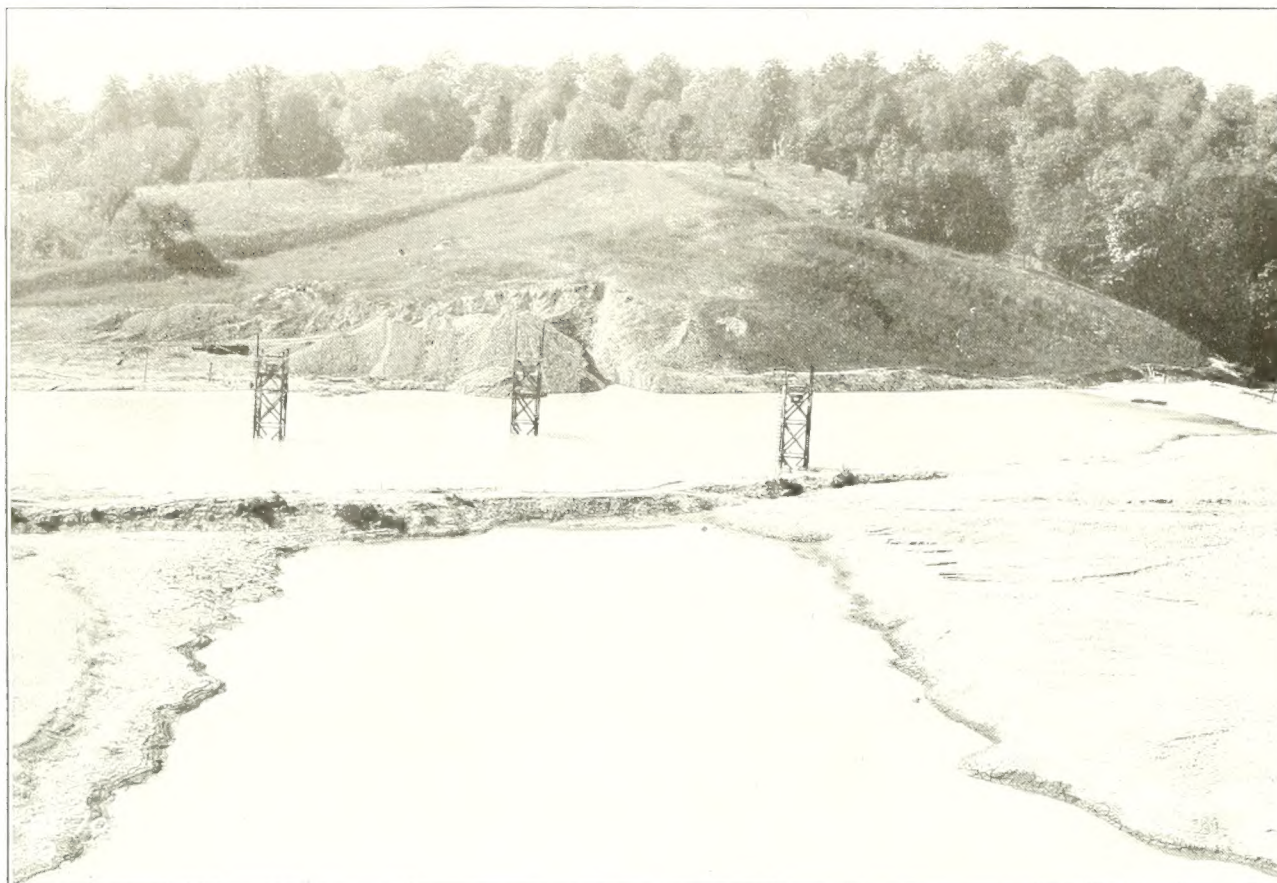


FIG. 29—HYDRAULIC FILL POOL AT GERMANTOWN DAM, SHOWING PRESSURE CELL TOWERS

The view is southward, across the damsite, nearly along the center line. The cleared hillslope in the distance is the south end of the damsite. The pool next it occupies the former bed of Twin Creek, now diverted through the conduits (which were too near the camera to be included in the picture). The dike between the two pools occupies the former north bank of the creek. It was thrown up to retain the waters of the nearer pool while the bed of the creek was being cleaned of objectionable materials not desired to incorporate in the dam. The wooden towers are built to carry the "pressure cells" (described on Page 45) used to measure the earth pressure in the core of the dam. This core is of fine consolidated silt and clay, pumped with the water and the rest of the earth from the "borrow pits" into the pool. The gravel and coarse materials are deposited on the sloping beaches (at the sides in the foreground). The silt and clay run into the pool with the water and settle slowly to the bottom. (See also opposite page). Taken Sept. 15, 1919.

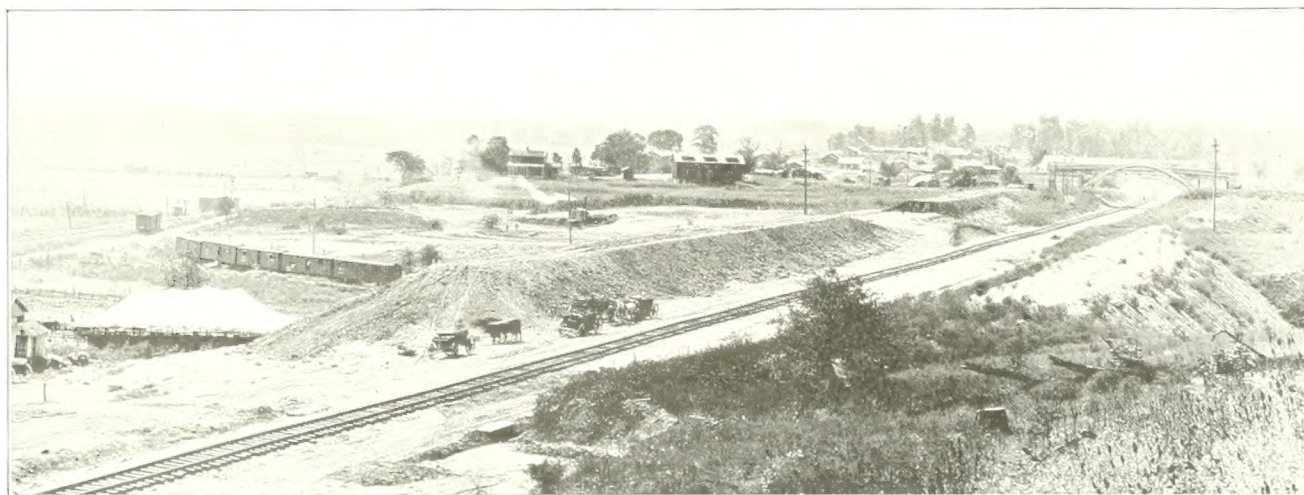


FIG. 30—RELOCATED B. & O. R. R. AT TAYLORSVILLE DAM, SEPT. 9, 1919.

The view is southeastward. The new track, not yet ballasted, appears in the foreground. On each side of it appear the new levees (see Fig. 33 and p. 37) which are virtual extensions of the dam to meet the high ground from which the picture was taken. The bridge shown on the outside front cover page is seen at right in the distance. (See p. 39). The old railway tracks appear at the left in the distance, with the hydraulic fill pool on the damsite beyond. The tent is a contractor's stable tent. The cars are the "rolling hotel" which accommodates his men.

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THE MIAMI CONSERVANCY BULLETIN

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Subscription to the Bulletin is 50 cents per year. At news stands 5 cents per copy. Business let-
ters should be sent to Office Engineer, Miami Conservancy District, Dayton, Ohio. Matter for pub-
lication should be sent to G. L. Teeple, Miami Conservancy District, Dayton, Ohio.

Death of T. W. Jaycox

The death has been announced, in Denver, Col-
orado, on Monday, September 15, of Mr. Thomas
W. Jaycox of that city. The death of Mr. Jaycox
is especially deplored by the engineers of the Con-
servancy District because of his membership on the
Special Board of Consulting Engineers who were
called in by the Dayton Flood Prevention Com-
mittee in March, 1914, to report upon the adequacy
of the Conservancy plans. The effect of the report,
which approved and confirmed the work of the Mor-
gan Engineering Company, gave added weight and
momentum to help carry the plans through the legal
preliminaries that were necessary.

Mr. Jaycox was born in Poughkeepsie, N. Y., in
1851, and was graduated at Cornell University.
From 1874 to 1880, he had charge of sewer design
and construction, street paving and the water works
for the city of Washington, D. C. Following this,
in 1880, he began private practice at Leadville, Col-
orado, his work including construction and reports
on water power and mining projects. He was suc-
cessively Deputy State Engineer and State Engineer
of Colorado, holding the latter position four years,
during which time he was the executive in adminis-
tering the irrigation laws and in the designing and
building of many bridges and state roads. Since
1909, and following this experience, Mr. Jaycox had
specialized in the designing and construction of
reservoirs, water works and irrigation projects.
This work, with the previous study on hydraulic
problems in connection with the many projects
which he passed upon as State Engineer, gave spe-
cial weight and value to his judgment in such mat-

ters. As a member of the Special Consulting Board,
he was one of those who came as guests of the Flood
Prevention Committee last June to inspect the con-
crete outlet structures at Germantown, Englewood
and Lockington, just completed at that time. It
was the last occasion on which his friends of the
Conservancy were to see him.

It is noteworthy that of the special Board of
Engineers referred to, eight in number, three have
died since their report to the Flood Prevention
Committee was made, the other two being General
H. M. Chittenden of Seattle, Washington, and Mr.
Wm. A. O'Brien of Cape Girardeau, Mo.

Interesting Hydraulic Development at Germantown

Most of the material which will go into the dam
embankment at Germantown will be obtained in
the main borrow-pit, occupying the width of the val-
ley bottom just above the dam site, the excavation
being done by a large dragline excavator. The quan-
tity thus delivered up to date has not been equal
to the full capacity of the dredge pump, and it was
therefore considered advisable to supplement the
work of the excavator by sluicing material down
from the adjacent hill side through a sluice way, the
material being excavated in this case by a hydraulic
monitor. It was known that the hill side contained
more clay than the valley bottom, which would
provide thus an additional quantity of fine material
for the earth core of the dam. Also, at times when
the dragline stopped work for any reason, the hill
side borrow pit would be still feeding material to
the dredge pump.

On putting the plan outlined into operation, a result followed which had not been foreseen and which gave it an additional recommendation. It was found that the large percentage of clay in the hill side material, as compared with the valley bottom borrow pit, caused it to act upon the dredge pipe as a lubricant, diminishing the pipe friction to such an extent that in spite of the additional material put through by the dredge pump, the total head remained the same. There was no increase in the gage reading on either the pressure or the vacuum side. The readings are taken regularly every hour, and the records covering several days, both preceding and following the change, seem to give assurance that the conditions indicated are stable. The material from the valley bottom borrow pit amounts to about 1500 cubic yards per day of two ten-hour shifts. The hillside borrow pit supplies an additional 500 cubic yards. The main borrow pit material comes to the pump during about 13 hours out of the 20. The hillside material is supplied almost continuously during the double shift. The motor (alternating electric), while pumping the latter material, is run on the oil switch alone. Also the pipe was being lengthened for several days following the change. The facts, put together, would indicate (since the unchanged gage readings show no increase in work on the part of the pump) that perhaps $\frac{3}{4}$ of the additional 500 cubic yards per day—or about 25 percent of the total—is being put into the dam, as far as the dredge pump is concerned, for nothing. Taking all expenses into account due to the installation and operation of the hillside sluicing plant, it is estimated that the hill side material is deposited in the dam at a cost of about ten to twelve cents per cubic yard. The entire operation furnishes an interesting and valuable experiment, details regarding which will be published at a later date.

Farm Division Issues Circulars

The Conservancy District, through its Farm Division, has begun the issue of a series of circulars, to be seven in number, relating to its agricultural lands, some 30,000 acres in all, lying within the five retarding basins. Part of these lands are now on sale and the circulars are for the information of prospective purchasers. Circulars No. 1 and No. 2 are ready for distribution.

Circular No. 1 gives a general description of the retarding basins, with their relation to the cities of the District and their effect during flood upon the farms within their boundaries. It is illustrated by an excellent general map in two colors.

Circular No. 2 treats of the effect upon the farm lands of such back water overflow as may cover them during seasons of flood, especially with relation to the deposit of silt, sometimes several inches in depth, remaining upon the surface of the fields after a flood has subsided. This circular contains much original and valuable material. In searching for information on the subject, Mr. Graham Smith, the head of the Farm Division, found that practically nothing had been published in this country. In Europe, especially in Germany, Austria and France, where retarding basins have been long in use, there were various articles scattered through technical journals. These were collected and studied. Let-

ters of inquiry were also sent out to all the leading agricultural authorities in this country whose experience or observation might be expected to bear on the subject. A considerable amount of original matter came in answer to these letters. The entire mass of collected data was sifted, studied and compared and the results embodied in Circular No. 2 of the Farm Division. Such being its character, this circular may well have a wide circulation among all those who are interested in farm lands anywhere which are subject to overflow.

Five additional circulars will be prepared, one for each of the five retarding basins, describing in detail the local conditions peculiar to each case. Single leaflets will be devoted to individual farms, the number of which runs upward of 150.

The labor involved in the preparation of all this information has been very considerable, but when one remembers that there are 30,000 acres to be sold, worth from \$100 to \$300 per acre, it will be seen that the beneficial results to be obtained are certain to outrun the cost.

The circulars may be obtained on request, together with any other information relating to the sale of the lands, by addressing the Farm Division of the Miami Conservancy District.

R. M. Riegel Becomes Designing Engineer

The position of Designing Engineer for the District, left vacant by the departure of Walter M. Smith, has been filled by the appointment of R. M. Riegel. Mr. Riegel first entered the service of the Conservancy in August of 1915, leaving it in May of last year for Government service with the Emergency Fleet Corporation in the Housing Division, from which work he returned to the Conservancy at the beginning of the present year. He brings to his position the experience of a number of years devoted to hydraulic engineering, including service on the Mississippi River channel improvement, with the New York Board of Water Supply, the Hydro Electric Co. of West Virginia and the Pennsylvania Water Supply Commission, on which he had charge of the Water Power Investigations. He was awarded the Fuertes gold medal for 1919 by Cornell University for his part in the investigation and publication regarding the action of the hydraulic jump, as described in Part III of the Technical Reports of the work of the Conservancy District. Those interested in the District have excellent reason to feel assurance that the work of Mr. Smith has fallen into capable hands.

Completion of Outlet Works at Huffman

The concrete outlet structure at Huffman will be completed by the time the present issue of the Bulletin is in the hands of its readers. The general type of this structure is the same as that at Lockington, described in the August Bulletin. It will have, however, when the conduits are added, three conduit openings instead of two, each 15 feet wide by 16 feet, 4 inches high, and carrying at maximum flood 35000 cubic feet of water per second. The total length of the structure is 580 feet, its maximum width outside 190 feet, its maximum height 108 feet, its height from bottom of conduit to top of walls 78 feet. It contains 33000 cubic yards of concrete, which the spillway will bring to 37000 cubic yards.

The Baltimore and Ohio Railway Relocation

Old Line Shifted Up the Miami Valley Slope from the Valley Bottom, Lifting It Thus Out of the Taylorsville Retarding Basin.

The line relocated was that branch of the railway which runs north from Dayton up the Miami Valley, the relocation work covering a distance of about nine miles. The changes are indicated in the two maps, Figs. 32 and 33. The old line, crossing the Miami River a little out of Dayton, follows the edge of the broad valley bottom at the foot of the western slope. About seven miles north of Dayton it reaches the site of the Taylorsville Dam. This dam, when completed, will block the valley from hill to hill, with its crest, about three thousand feet in length, 51 feet above the former railway subgrade and extending about 1200 feet up the valley slope to the west of it. For a distance of about four miles north of the dam, the track lies within the flow line of the retarding basin at maximum flood. The necessity for relocation is evident.

The natural solution was to throw the railway line a sufficient distance up the western valley slope to clear the damsite. But the crest of the dam being at elevation 837 feet above sea level, and the railway yard in North Dayton at elevation 752.1, the gradient necessary to climb from the yard to the crest, the distance being $6\frac{1}{2}$ miles, would be steeper than was desired. The maximum gradient set for the new line by the Railway Company was 0.2% (2' in 1000), and less on curves by an amount necessary to compensate for the curvature. This made the highest elevation which it was possible to reach at the dam, 819 feet above sea level, which is 18 feet below

the crest. It was thus necessary to notch the top of the dam to this depth to permit the passage of the new line, and to enclose the tracks, as they proceed north, between levees. These levees, which are virtual extensions of the dam structure (see Fig. 33), stop about a thousand feet north of the dam center line, where they meet the mouth of a heavy cut in the railway line. Drainage for the country to the west at this point is provided by an 8-foot concrete arch 273 feet long passing under the railway tracks and both levees.

The 0.2% gradient, continued north from the dam, brings the subgrade at the mouth of the levees just one foot above water level as it will stand in the Taylorsville Basin for a flood 40% greater than that of 1913. To keep a flood greater than this, if it ever occurs, from running down the tracks between the levees, a wall of sand bags would have to be built across the right-of-way from levee to levee. In such a case, the new line up the valley would be temporarily out of use. It is not expected, however, that such a flood can ever occur.

The elevation of the old line, to permit the relocation to reach the elevation indicated at the dam, begins at Leo Street in the North Dayton yard. The old alignment is followed to the Miami River Bridge, 5300 feet further north, this bridge being elevated 7' 1". The gradient to the bridge, which is within the yard limit, is 0.255%. From the bridge north, the new line continues to follow the old one for 4800 feet, then swings to the left and climbs

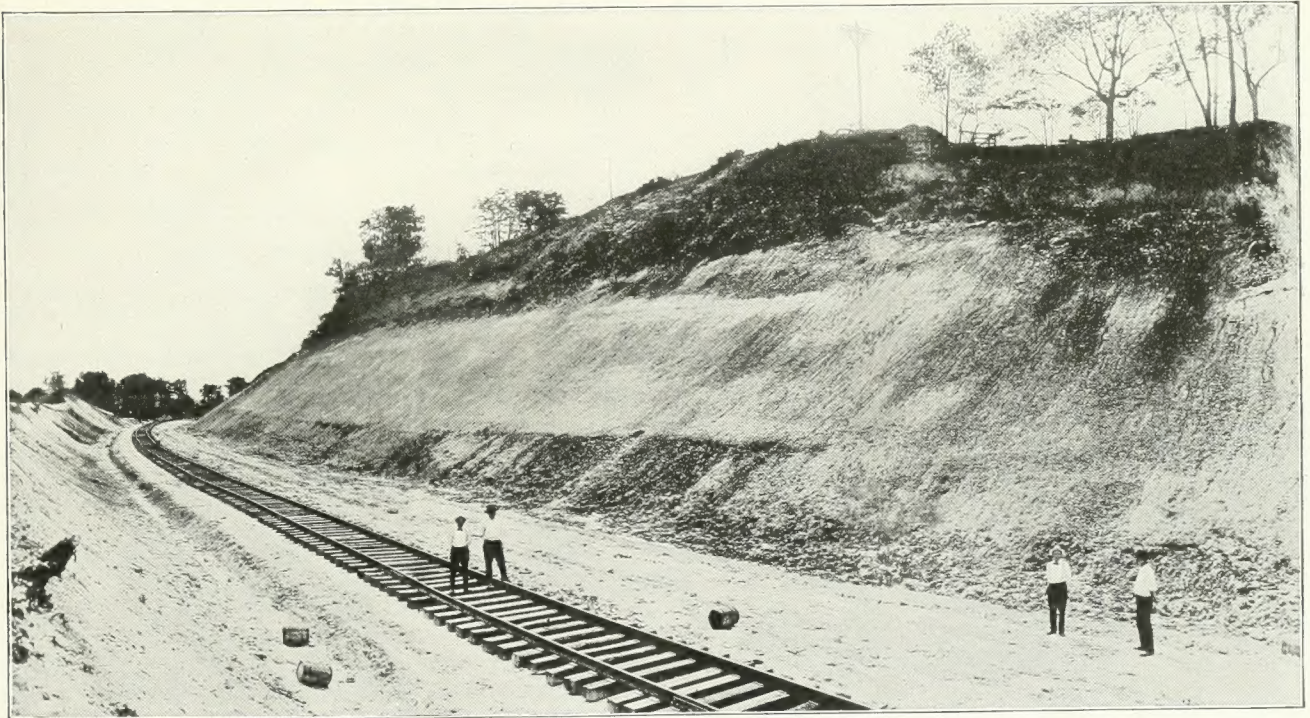


FIG. 31—HEAVIEST CUT ON B. & O. R. R. RELOCATION, SEPT. 9, 1919.

This cut begins just opposite the camera set up in figure 30, and extends northward about 2200 feet. The view here is southwestward near the north end. The maximum depth (seen at the right) is 80 feet. The cut contained 145,000 cubic yards of earth. The roadbed is for double track, the subgrade 42 feet in width.

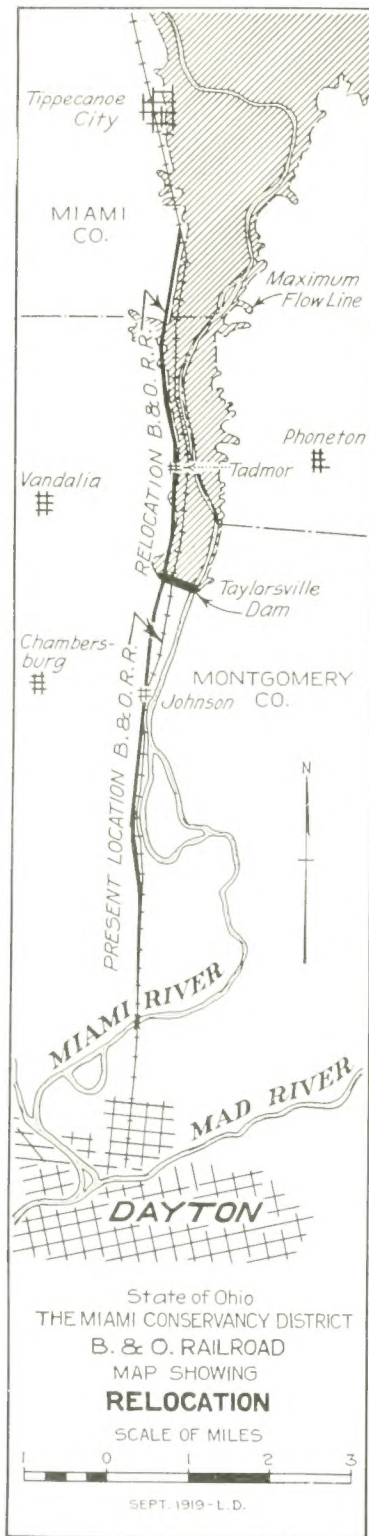


FIG. 32—B. & O. R. R.
RELOCATION

The old location is seen running north out of Dayton, with the relocation (the heavy line), branching off and running beside it a little to the left. The new line is about nine miles long, the roadbed (42 feet wide in cut and 34 feet in fill) built for double track, but only one track to be laid at present, with a passing track extending from Johnson to Tadmor.

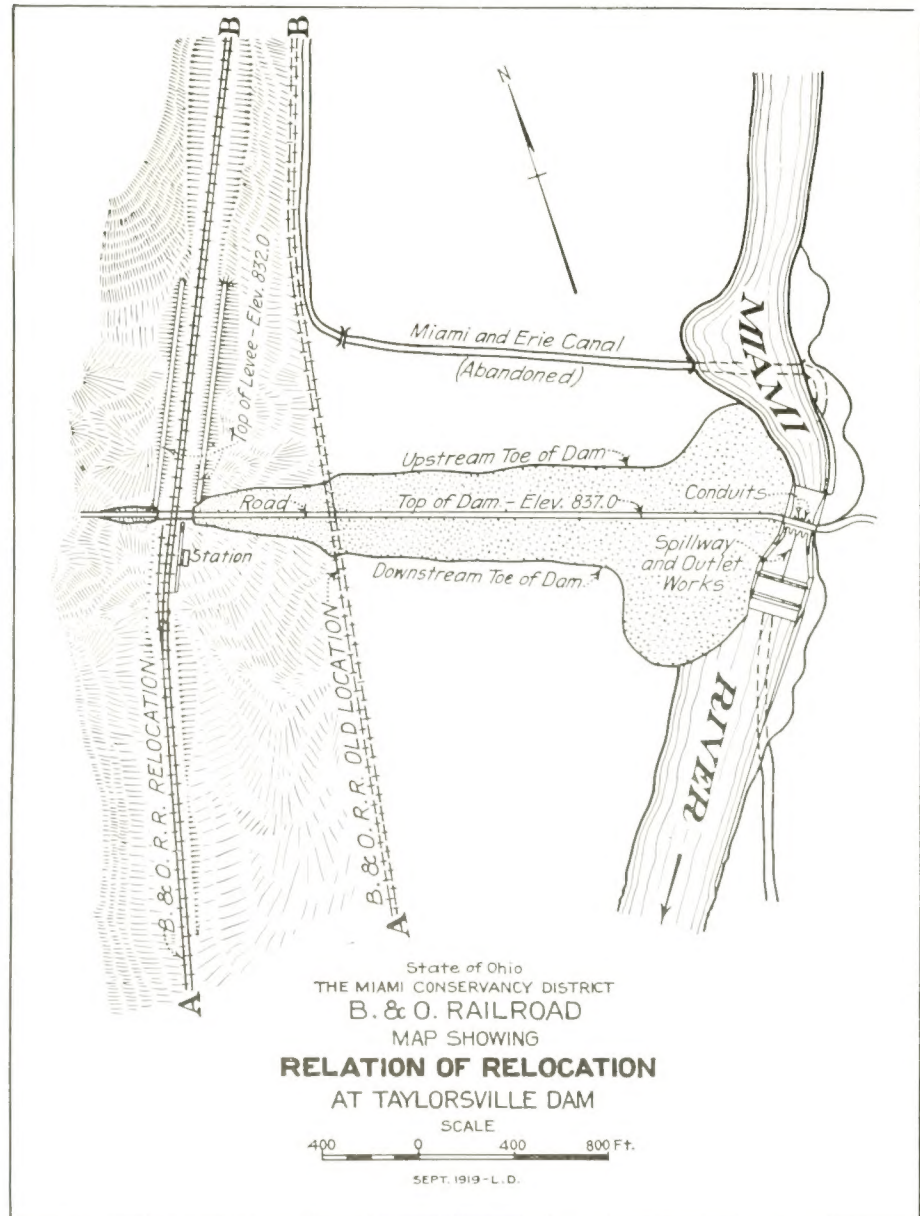


FIG. 33—B. & O. RELOCATION AT TAYLORSVILLE DAM.

The damsite is shown stippled, extending across the valley. The old tracks cross the damsite about 1200 feet from its western end. The new location is about 700 feet west of the old. The highway to be built across the damsite (the relocated National Road) crosses the new tracks on the bridge shown on the outside front cover. The railroad levees (see Fig. 30) carry the dam structure north to connect with the hill seen in the upper left-hand corner. The new station, to be built, is shown just south of the bridge.

along the western slope of the valley to the north end of the railway levees referred to, the 0.2% gradient being maintained the entire distance from the bridge. North of the levees the new line runs level to the end of the relocation, except for a single climb, on 0.05% grade, of one foot. The relocation is nine miles long and ends about four miles north of the dam. The length of the approach grade from Leo Street to the Miami River bridge is about 1.9 mile. Connecting the relocation with the Weston Division of the railway, there is a cut-off 3600 feet in length, beginning at Tate's Point and rising on a 0.3% grade to join the revised line just south of the Miami River bridge.

The old location of the railway was the natural one. Running as it did along the river bottom at the foot of the valley slope, most of the grading was light side hill work, or a light fill. The new location, being lifted vertically a maximum of about 32 feet, and shifted westward a

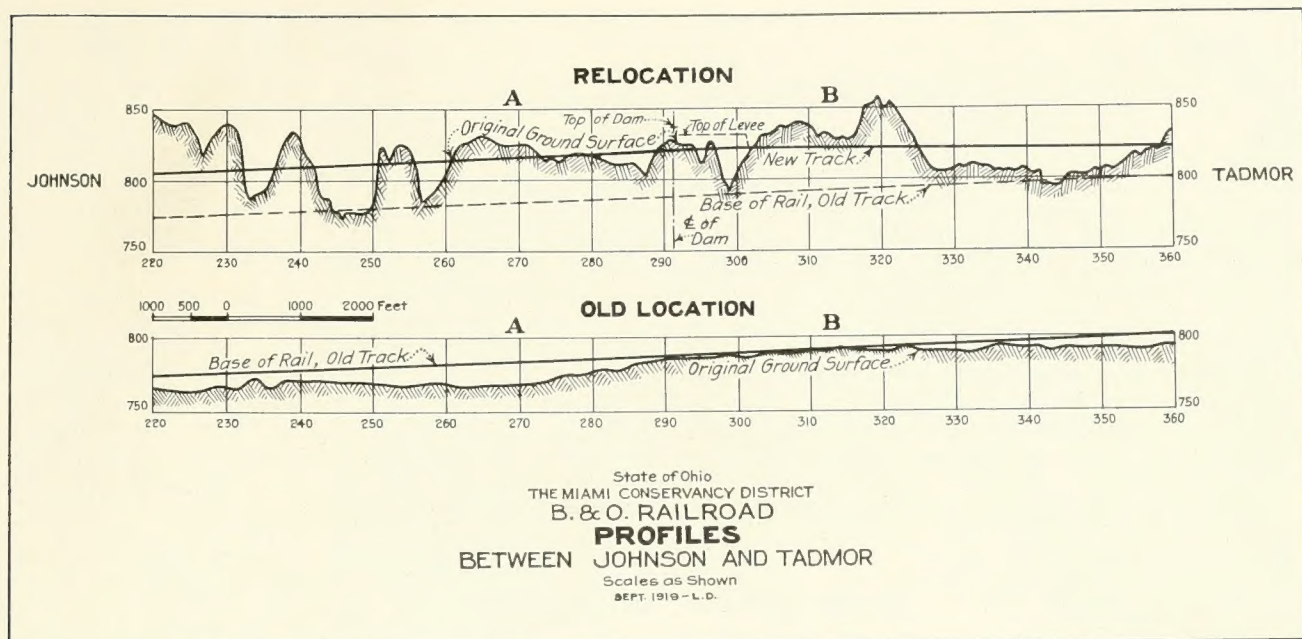


FIG. 34—PROFILES OF NEW AND OLD LINES, B. & O. R. R.

The profiles are shown side by side, for comparison, over the distance from Johnson's to Tadmor. (See Fig. 32). The portions from A to B cover the distances AB in Fig. 33. The top of the dam and the top of the adjacent levees are also shown. The figures at the ends of the profiles give elevations above sea level. The figures under the profiles give "station numbers" along the new line. The rougher country traversed by the relocation shows plainly.

maximum of 800 feet or more, is carried far up the side of the valley, where it must cross many gulleys and tributary valleys which furrow the main slope. These side valleys had to be filled up and the intermediate shoulders of the main valley cut through. This meant expensive construction. The contrast between the two lines in this respect is shown clearly by the two profiles in Fig. 34.

The old road is a single track line, with a passing track from Johnson to Tadmor. The new subgrade is built for two main tracks, although only one will be constructed at present, with passing tracks opposite the old ones. The extra width of subgrade is paid for by the Railroad Company. The total amount of earth excavation necessary was about 850,000 cubic yards. The heaviest cut is a little north of the Taylorsville dam, amounting to 145,000 cubic yards. Another, north of Johnson's, amounted to 135,000 cubic yards. The two heaviest fills are one north of Picayune Creek, and the other north of Taylorsville Damsite, each comprising about 100,000 cubic yards.

The excavation was done by several methods. The heavier cuts were made by 70-ton steam shovels, the material being transported on narrow gage tracks in 4-yard or 6-yard dump cars drawn by steam dinkies. The lighter cuts were made by teams and wheeled scrapers. The intermediate work was handled by elevating grader and by small revolving steam shovels, transportation in each case being by dump wagons. The exigencies of the relocation did not permit a balancing of cut and fill. The excess in the cuts went to widening embankments. The regular road bed width is 42 feet in cut and 34 feet in embankment. The slopes are finished $1\frac{1}{2}$ to 1 both in cut and fill.

The general contract for the work of grading was let to Grant Smith of New York. It was directly

handled, however, by H. C. Kahl of Davenport, Iowa, who sublet portions to Kahl Brothers, the Vang Construction Company, and Condon & Smith. The contract price for the entire work was 60 cents per yard "unclassified." The only rock encountered was a small yardage in the heavy cut north of Taylorsville. The grading was begun in May, 1918, and completed ready for track-laying in August of this year. This refers to the new line, which begins 4800 feet north of the Miami River bridge. The raising of the grade from this point back to the yard at Leo Street in Dayton, where it begins (a distance a little short of two miles), is handled by the Railway Company and is now in progress.

The most important bridge structure on the new line, is a concrete arch (see Fig. 28) built to carry a highway which is to lead across the top of the Taylorsville dam. It is of the three-hinged, two-ribbed type, the span of the main arch being 92 feet. To secure the necessary clearance above the double track railway below, the grade of the bridge floor is elevated ten feet above the dam crest, with approach grades from each end. To keep the ribs above the clearance line, the rib center line is raised 6 feet above the crown of the roadway at the center of the arch. This makes the middle 44 feet of the floor a suspended structure. The end portions of the floor are carried upon smaller concrete arches, there being three pairs of these at each end of the bridge. These arches are carried upon reinforced concrete posts and open abutments, the two inner pairs of posts resting upon the arch ribs, making the inner arches thus spandrel arches. The total length of the structure is about 135 feet.

The other principal bridges are a 30-foot arch at Poplar Creek, a 20-foot arch at Johnson's, and a 26-foot arch at Picayune Creek, all of concrete. At

Poplar Creek and Johnson's, the structures accommodate a highway undercrossing as well as the water way. The smaller water openings are standard B. & O. concrete arches, or concrete or cast iron pipe with concrete head walls. There are 78 openings in a distance of nine miles, as against 50 in the old line, the extra number bearing evidence of the rougher country traversed by the relocation. The viaduct at Taylorsville dam was built by the Conservancy District. All the other bridges and culverts were built by the contractors.

The cost of the new line was borne by the Conservancy District, except for certain features wherein it represents a betterment of the old. Such betterments are paid for by the Railway Company. For instance, the new line eliminated 38° of curvature, representing an operation expense which, capitalized, amounts to \$18,557. The benefit to the railway by elimination of possible flood damage was

assessed at \$493,097.00. On the other hand, the new line is 100 feet longer than the old, which little distance costs the District \$4,432.00 simply for capitalization of the additional expense of operating trains over it. The extra cost of maintaining the new line, as against the old one, for the first six years, gives an item of \$83,650.00. The total cost of construction, not including tracklaying, ballasting, fencing, telegraph line or signal system, is estimated to be approximately \$825,000.

Supervision of the work for the Conservancy District has been exercised by Albert Larsen, Division Engineer, with Wm. Kramer, Asst. Engineer, in direct charge, succeeded later by W. E. Duckett, Asst. Engineer, Mr. Kramer being transferred to a similar position on the Erie and Big Four work. The interests of the railway have been in charge of Mr. A. H. Griffith, Engineer of Construction, and P. A. Callahan, Assistant Engineer.

September Progress on the Work

GERMANTOWN

During the month of August slightly over 50,600 cubic yards of embankment were placed in the dam. This brings the total for the first two months of pumping to 85,600 cubic yards. A revolving screen has been installed to separate the oversize rock from the material fed to the pumps, taking the place of the revolving grizzly formerly used. The new screen increased the efficiency of the pumping plant to such an extent that the borrow pit dragline could not dig the material fast enough to maintain continuous pumping for a full day. A hydraulic giant was therefore placed on the hill north of the pumping plant, the eroded material being sluiced directly into the hog trough. This has greatly accelerated the amount of material pumped and consequently reduced the cost per yard.

Towers have been erected in the old creek channel for obtaining the vertical and horizontal earth pressures in the dam. These towers are to remain permanently in the dam and for this reason have been heavily guyed.

The small Marion dragline has finished excavating the cut-off trench in the old creek channel and is now at work grading the slopes of the dam.

Since the earth blanket has been placed in the old creek bed the teams used for that purpose have been shifted to the spillway, where they are making fair progress.

The railroad track along the borrow pit for hydraulic embankment is being extended up the valley for future use.

Arthur L. Pauls, Division Engineer.

September 19, 1919.

ENGLEWOOD

The Lidgerwood steam dragline has continued cleaning up the river bottom and is placing a four-foot blanket of impervious material over the gravel bottom on the east side of the river.

Work has continued on the cross dam which is now at elevation 829, within 11 feet of completion.

During August 113,000 cubic yards of embankment were placed in the dam, bringing the total to the end of August to 636,000 cubic yards and showing a completion of 18 per cent. On September 6, 7,380 cubic yards of material were pumped into the dam during the 20 hours covered by the day and night shifts, establishing a record for the day shift of 3,830 cubic yards and for the night shift of 3,550 cubic yards. A booster pump has been installed on the north side of the dam at the first berm and was put in operation today. Material for the easterly end of the dam will be pumped through this booster.

The graveling of Highway No. 4 was completed the latter part of August.

H. W. Horne, Assistant Division Engineer.

September 15, 1919.

LOCKINGTON

Since the first stage of the concrete outlet structure was finished in the latter part of May and Loramie Creek turned through its new channel, the principal work at Lockington has been placing the earth fill which forms the dam. On September 1 approximately 15 per cent of the total fill had been built.

The 3½-yard Lidgerwood dragline is building the west-
era 3400 feet of the dam. This part is comparatively low and as the material can be taken from a borrow pit extending along the north side of the fill, the work can be particularly well handled by dragline. On the other hand it would not be economical to do it hydraulically as are the other parts of the dam. The small yardage, high lift, and long discharge pipe required are all factors against the hydraulic method for building this part of the dam.

The hydraulic fill now being placed in the main body of the dam across the original valley bottom is progressing favorably. Material is being deposited by a 12-inch discharge pipe along each toe of the dam. The material on the north side is placed inside (south) of the dyke recently built by the dragline. The material from the borrow pit has proven to be very satisfactory.

Construction of the roads connected with the dam is nearing completion. About two miles will soon be open to traffic. Road No. 9 was graded during the month from Lockington to a point one-half mile north, where it joins work previously done. A concrete slab bridge was built on Road 9 over the Canal Feeder at Lockington. The culverts are built and grading is well along on that part of Road 8 west of the dam. Roads 9 and 10 have been surfaced with gravel from the stock pile which was left from the concrete work. The remainder of the pile was shifted by the Class B (1½-yard) steam dragline to positions in the outer portions of the dam, where it will form a part of the permanent fill.

The soil stripping, now nearing completion, is being done by the steam dragline, which places the soil outside the south toe of the dam.

Barton M. Jones, Division Engineer.

September 19, 1919.

TAYLORSVILLE

The Lidgerwood Dragline continues to make good progress on the outlet works excavation. The output for the month of August was considerably larger than for any previous month, due, probably, to the fact that it was working over the hump between the two submerged wiers and had only a 41-foot face to work against as compared with the 53-foot face just south of this point. Also the 3-foot to 5-foot layers of solid rock that were encountered further north, at elevation 755 to 770, have disappeared and much thinner layers are now found at this elevation.

The Marion steam shovel has completed the excavation for the new loading track around the north end of the concrete inlet, and is held here as reserve equipment for digging ballast for the B. & O. relocation. This shovel also removed all material down to elevation 789 between this track and the old loading track near center line of dam.

The Bucyrus Dragline is digging gravel ballast for the B. & O. relocation.

One stiff leg derrick has been erected for placing concrete in the outlet works and the other one is being erected. Concreting will start in about two weeks, provided the delivery of ballast to the B. & O. does not interfere too much with the delivery of gravel to the gravel plant.

The sluicing has made fair progress. The face in the borrow pit is so high (50 to 55 feet) and the material so hard, that at times it overhangs badly and makes it dangerous to keep the monitor moved up close enough for the best service. To overcome this difficulty, a well drill was placed on top of the bank, and about 10,000 cubic yards were drilled and shaken heavily with black powder. This is largely an experiment, but apparently will prove to be an economy. Our estimates, of course, will show this a little later.

O. N. Floyd, Division Engineer.

September 17, 1919.

HUFFMAN

Work on the placing of concrete in the outlet structure has progressed to such a point that it can be safely estimated that practically all of this year's requirement will have been put in by October 1st. The upstream weir has been completed and the floor and walls are completed down to the downstream weir. This weir is 30 per cent completed and the concrete apron below the weir is 50 per cent complete. This leaves about 1,500 cubic yards of concrete remaining to finish this year's work.

The electric dragline has cleaned out all objectionable material from the old bed of Mad River and has been taken across the present river channel to the large borrow pit above the dam. The machine is receiving a general overhauling before starting the excavation of material for the earthen part of the dam.

The installation of the hydraulic pumping plant has been completed except setting up the pump, which is being transferred from one of the other jobs, so that the pumping of material into the dam will be started within the next few days.

Work has been started on the building of culverts for the relocation of the Valley Pike around the end of the dam.

Contractor Geiger has completed the impervious blanket on the upstream half of the dam.

C. C. Chambers, Division Engineer.

September 17, 1919.

DAYTON

Channel excavation to date amounts to 542,100 cubic yards. A total of 385,900 cubic yards has been placed in levees and spoil banks, including 60,000 cubic yards of levee embankment on Contract No. 41. In accomplishing this a total of 931,200 cubic yards has been handled.

The D-16 large dragline has completed its work above Dayton View Bridge and at this writing is dismantled and about to move under the bridge to begin work between



FIG. 35—HYDRAULICKING DOWN HILLSIDE AT GERMANTOWN

This shows the hillside borrowpit referred to on pages 35 and 36. The earth is excavated by "boring in" at the bottom of the face of the pit with a powerful jet from a hydraulic "monitor" (seen at the left) and thus undermining the face till the material falls down; then washing it into a trench which carries it down the slope to the "hog-box," whence it is pumped to the dam. Water is supplied to the monitor by two powerful centrifugal pumps. Additional water for washing the material down the trench is supplied by a third pump. Taken Sept. 15, 1919.

that bridge and Sunset Avenue dam.

The D-19 Class 9½ caterpillar dragline has completed its work on the left levee above Herman Avenue. It has also excavated a channel under Dayton View Bridge for the passage of D-16 and is now about to begin the enlargement of the right levee above Herman Avenue.

About half the concrete in the retaining wall on the north bank of the river west of Main Street has been placed.

Scow No. 3 is being repaired in the Sunset Avenue dry dock.

At Price Brothers' plant approximately 145,000 concrete blocks have been completed, this being about 80 per cent of the number required for the work at Dayton.

C. A. Bock, Division Engineer.

September 17, 1919.

HAMILTON

The total amount of excavation for the two drag lines to September 1, 1919, was 795,000 cubic yards. The electric dragline has completed the center cut between the railroad bridge and the Columbia Bridge and will now take out the remaining cut south of the Columbia Bridge on the east side of the channel. The steam drag line has placed about 12,000 cubic yards in the levee between the Ford plant and the B. & O. R. R. and has done miscellaneous work around the Ford plant.

The work of driving steel sheet piling under the B. & O. bridge at Old River has been about 50 per cent completed. Considerable difficulty has been experienced on this work on account of the low arches giving insufficient head room for the pile driver.

Excavation on the Front Street sewer has been completed. The concrete work has been completed to the gate man-hole in the levee. The work remaining to be done is that of driving piling for the outlet section and concreting the same.

Old bridge iron, wreckage from the 1913 flood, amounting to 67 tons, has been removed from the river.

Frank McGillicuddy & Co. have completed their excavation contract north of Black Street.

C. H. Eiffert, Division Engineer.

September 20, 1919.

RAILWAY RELOCATION

B. & O. Relocation. The grading is practically completed. There remains some ditching and finishing. Roberts Bros. have finished laying the main track. The passing track will be laid by September 25. The tracklaying machine has been transferred to the Big Four and Erie at Enon.

Some ballasting has been done and it is expected that this will proceed at a rapid rate so that the Baltimore & Ohio traffic can be diverted to the new line by November 1, 1919. The ballast is gravel, obtained from the valley floor just below Taylorsville damsite.

The elevating of the B. & O. tracks south of Needmore Road is now about 50 per cent completed.

Most of the material for the right-of-way fence is on the ground and fencing will be started soon.

Big Four and Erie. All excavation in the big cut at Huffman for the Big Four and Erie and the Ohio Electric Railway is completed. The Walsh Construction Company have moved the shovel to the borrow pit near Harshman.

George W. Condon's shovel has finished its work and it is now being repaired.

Roberts Bros. are unloading track material and laying track at Enon.

The District has begun work on the overhead highway bridge at Huffman and has about 50 per cent of the false work erected.

Ohio Electric Railway. The District has finished the grading between Mud Run and Carlisle Junction. The

two draglines which were used are now being dismantled and will be sent to Dayton on river work.

All concrete work is completed.

McCann has all grading finished except a small cut at Springfield Pike.

The tracklaying and ballasting between Huffman Hill and Fairfield will start just as soon as the Big Four and Erie track work is completed.

A. Larsen, Division Engineer.

September 22, 1919.

RIVER AND WEATHER CONDITIONS

The streams throughout the valley were comparatively low during the month of August. The rainfall at the District's stations was about normal, varying from 1.90 inches at Fort Loramie to 3.38 inches at Ingomar. The number of days on which the precipitation exceeded 0.01 of an inch varied from 5 to 9 at the different stations. The total precipitation at the Dayton U. S. Weather Bureau Station was 3.12 inches, or 0.11 inches greater than normal, reducing the accumulated deficiency since January 1 to 1.52 inches.

At the Dayton U. S. Weather Bureau Station the mean temperature for the month was 71.5 degrees F., or 1.9 degree less than normal; there were 14 clear days, 133 partly cloudy days, 4 cloudy days, and 11 days on which the precipitation exceeded 0.01 of an inch; the average wind velocity was 8.2 miles per hour, the prevailing direction being from the southwest; and the maximum wind velocity was 57 miles per hour from the west on the 16th.

Ivan E. Houk, District Forecaster.

September 24, 1919.

The Conduit Forms at Englewood and Germantown

Interior Forms Built in Upper and Lower Sections Which Loosen from the Walls and Roll Forward on Casters.

By Walter M. Smith, Designing Engineer

The outlet conduits of the separate type so far completed,—those at Englewood, described by Mr. McCurdy in the last issue of the Bulletin, and those at Germantown described in the June issue—are of practically the same design. They consist in each case of two parallel concrete tubes, opening and expanding at the ends for entrance and for exit of the stream flow. The interiors of the tubes, in their present condition, are practically alike not only in design but in dimensions. At present the interior area of each single conduit is 252 square feet, the maximum width 13 feet, the length at Englewood 709 feet, at Germantown 546 feet, the maximum height at Englewood 22 feet 6 inches, at Germantown 22 feet 10 inches. At both places the conduits were built in sections about 30 feet long, the interior dimensions of all sections being the same except at the upstream and downstream ends.

Concreting was carried on in each section in five successive stages as indicated in Fig. 37, joints being introduced at each of the stages. The four joints thus introduced into the arches were for the purpose of avoiding high temperature stresses which would have occurred if fixed arches had been used. These joints made the construction of the arches much slower and more expensive than that of the walls, but this additional cost was believed worth while considering the added safety gained.

The conduits being built in a trench cut in rock, (see Fig. 37), exterior forms were not necessary except for the arches, the rock itself taking the place of exterior forms for the walls and floor.

To save expense the twin conduits were carried forward in the construction simultaneously, in sec-

tions 30 feet in length, the interior forms for each conduit being exactly similar, set side by side, and enclosed at the ends by transverse bulkheads (see Fig. 36). When the concrete of a section had set, the forms were collapsed, rolled forward 30 feet along the excavation and set up again. The forms rolled on truck casters attached to the bottom pieces, track being furnished by the already finished floor or, in the case of the upper forms, by shoulders in the lower walls. These shoulders will also furnish side support to the floor of the permanent conduits, as explained in Mr. McCurdy's article. The collapsing of the forms was really not complete collapsing, but simply slackening to detach them from the concrete, as explained below.

The Lower Forms

These are built in two entirely separate similar halves, in order to permit them to collapse free from the finished concrete and roll forward in the manner just indicated. One of the halves is shown in the lower part of the left-hand portion of Fig. 36, and the two together, side by side, in the right-hand conduit in the same figure. Each of these independent sections consists of a set of cross frames held in position by longitudinal and diagonal bracing in both horizontal and vertical planes, thus creating vertical and horizontal trusses. The horizontal trusses are required to hold the form rigid against the pressure of the poured conduit, since each 30-foot section could be held rigidly in position only at the ends.

The two sections were held together at the center by steel plates on each side of the upper and lower

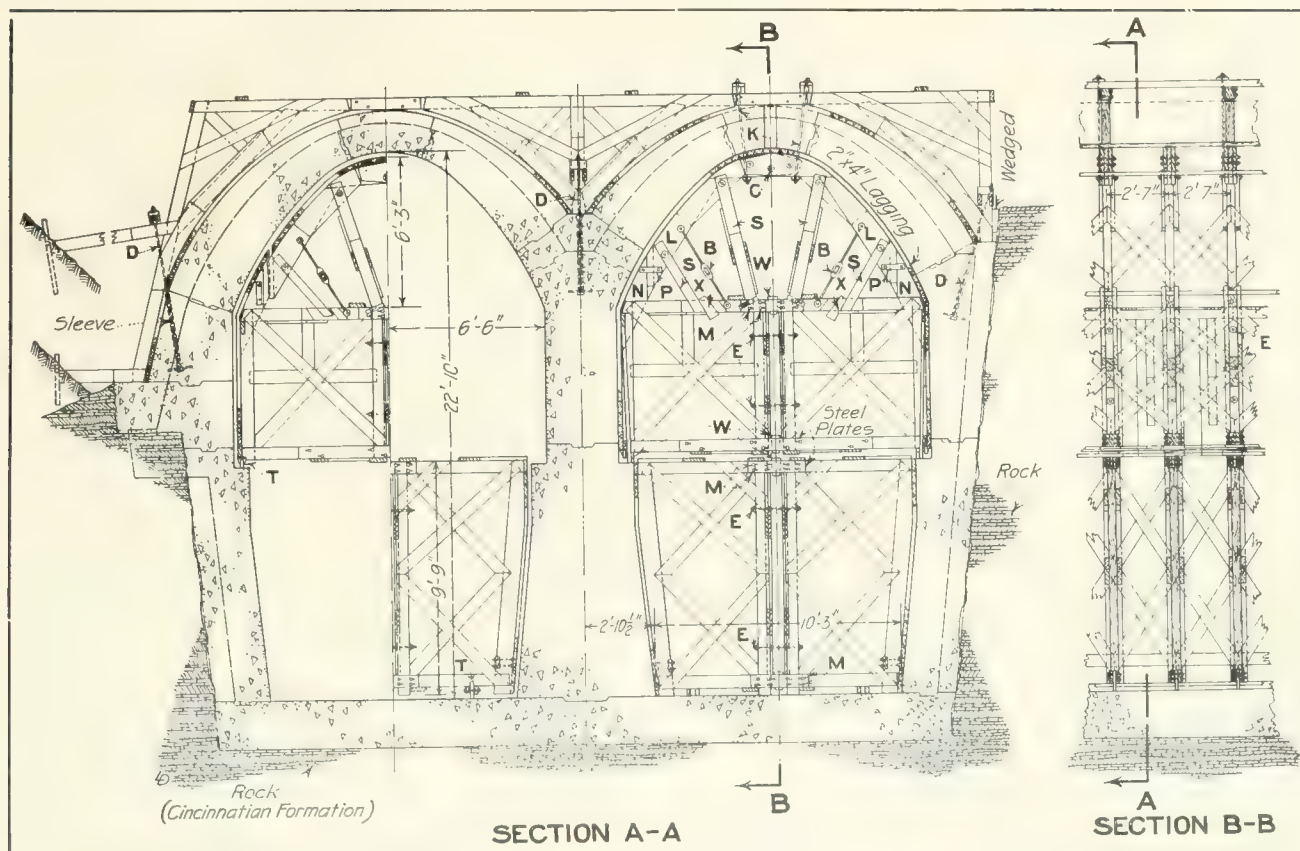


FIG. 36—CONDUIT FORMS AT ENGLEWOOD AND GERMANTOWN

chord members of the cross frames, and also by two bolts EE, through the inside vertical members of the cross frames. These bolts were threaded their entire length and had four nuts and washers each. They were used to draw the sections together when desiring to move ahead and also to force them apart when setting up in the new position. The steel plates on the chords had slotted holes so that when the nuts were loosened on bolts M the sections could be drawn together. When the forms were in position for concreting reliance was placed neither on the bolts M through the plates nor on the adjusting bolts E, but upon oak wedges, driven between the ends of upper and lower chords along the center line. (The wedges correspond to those marked "W" in the upper form.)

When the form was to be moved ahead the bolts M were loosened, the wedges driven out and the two sections drawn together a sufficient distance by means of bolts E; then raised by a set of jacks and a set of heavy truck wheels placed in position as shown in left-hand conduit. The sections were then lowered until the truck wheels rested on the floor, and the form moved ahead to the new position and set by reversing the processes.

The lagging consisted of 2" dressed pine and was not protected by steel sheathing. The forms were in fact built of wood throughout, steel being discarded as too expensive. With a little care in the selection and handling of the lagging a perfectly true and smooth surface was obtained.

At Englewood these lower forms were set up and used 22 times in succession; at Germantown 18 times, and except for the lagging becoming some-

what rough by spading of the concrete along its surface, they were still in good condition when the conduits were finished.

The weight of one complete 30-foot lower section for one conduit was 10 tons.

Upper Interior Forms

These consisted of two main parts, a rectangular part for the upper side walls and a segmental part for the arches.

The general design of the rectangular portion was similar to that of the lower forms, including the two separate halves with the steel side plates, wedges, and adjusting bolts E. There being no supports under the center, however, the side plates on the lower chord members were made 8 feet long, in order to keep this member in line. The truck casters on which the form rolled forward are indicated at T, to the left in Fig. 36.

To facilitate collapsing, the arch ribs of the segmental part of the form were built in four parts. The triangular pieces NN at the lower ends were rigidly attached to the rectangular form below. The segments LL were pivoted together at C. They were bolted together also by the bolts adjacent to C. LL and NN were connected by slotted straps PP tightened by bolts and nuts.

The weight of these parts was carried to the rectangular form below by means of the diagonal struts SSSS, the lower ends of these bearing directly upon the upper chord of the form, and the pieces LL were held rigidly in place for the concrete by forcing the lower ends of the struts away from the center line of the forms by means of threaded straps for the

the center strut, and by wedges for the two outer ones. See Fig. 36.

To collapse the forms, the straps PP are loosened. The straps and wedges holding the bottoms of all four struts are loosened and the strut bottoms driven toward the center line of the forms. The turnbuckles BB are then tightened, pulling down and in on the two pieces LL, the latter turning on the pivot C, the other two pins near C having first been pulled out. The rectangular part of the form is then collapsed like the lower form, drawing the entire upper form away from the walls and down from the arch, permitting it to be rolled forward on its castors into its new position.

The carrying of the weight of the arch form by the rectangular section below necessitated the making of the latter into a very rigid truss. This was done by means of the diagonal braces shown. The arch ribs consisted of three layers of 2" plank cut to shape and spiked together, the layers interlocking where the parts of the rib were pivoted together. The interior and exterior arch forms were bolted together by the bolts KK. These bolts were removed of course to collapse the interior form.

One 30-foot section of upper interior forms weighed 15 tons, yet in many cases the moving ahead only took about eight minutes.

Both the upper and lower forms were made sufficiently long for one end to bear inside on the finished concrete of the preceding section and for brackets to be bolted upon the other end to hold the ends bulkhead. These brackets were detached and the bulkhead removed before collapsing the interior forms.

In rolling the forms forward during construction many of the truck wheels (used on the lower forms) and casters (used on the upper forms) were broken. This was due to the irregularity in the elevation of the concrete upon which they rolled. This would sometimes throw a load many times as great as was intended on the wheels or casters and break them. A special wheel and caster was then designed and no further trouble was experienced.

It will be noticed by referring to Fig. 37 that when the concrete was poured in the lower portion it was carried about 8 inches above the side shoulders to act as a guide in setting the upper forms. This was very easy to do and was very important.

The number of forms to be provided was based on the estimate that one floor section could be placed every 2 days, one lower side wall section every 3 days, and one upper side wall and arch section every 6 days. One set of lower interior and two of upper interior forms were therefore provided. One set of upper forms was planned to be set up over the first completed section of the lower portion as soon as the latter had aged 2 weeks. A second upper set of forms was planned to start when the lower forms, which began concreting at one end of the conduits, had passed the center line of the dam. In this way the upper and lower parts of the conduits would be finished about the same time. This program in the beginning was realized, but labor scarcity due to the war led to some lagging in the schedule for the upper halves of the conduits. The slower relative speed in building the arch sections was in part due

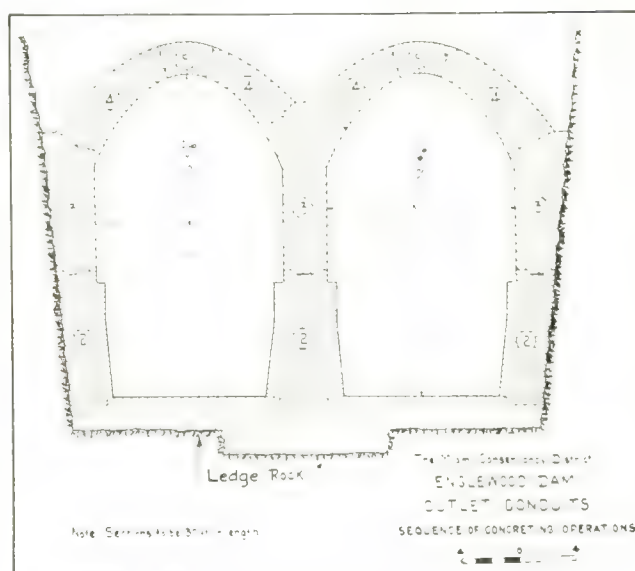


FIG. 37—SECTION OF ENGLEWOOD CONDUITS

Shows the setting of the conduits in the ledge rock, and also the five successive stages in the pouring of the concrete, longitudinal joints being introduced at each stage.

to the introduction of the four longitudinal joints into the arch design.

Exterior Forms.

The general design of these is indicated in Fig. 36. The conduits being built in deep rock excavation, exterior forms were only necessary for the arches. To facilitate handling, they were designed in three parts, one for the two inner halves of the arches and one for each of the two outer halves. The parts were held together at the conduit crowns by steel side plates in the same manner as the interior forms, except that the holes in the plates were not slotted. They were held down by bolts D along the center line of the twin conduits and along the outside of each conduit, and were rigidly held to the interior arch forms by means of the bolts K at the crown. The holding down bolts D passed through large plate washers buried in the concrete at the lower end, with a nut on the under side of the plate, and were incased in a tin sleeve in the concrete so that they might be unscrewed and taken out when there is no further use for them. The concrete surrounding these plate washers as a rule was only 36 to 48 hours old when the haunch arch sections were poured. On this account these plate washers had to be very large so that they would hold almost solely by the weight of the concrete above them, especially as nearly all of the work was done in the six coldest months when the concrete set very slowly.

After the haunch sections had set for a day the bolts K were taken out and the crown key section concreted without a top form.

After the upper interior form was moved ahead the exterior form was taken apart and moved ahead in sections, then reassembled in position over the interior form and the bulkhead forms set in position. On account of the variation in thickness of the arches, this thickness increasing steadily from the ends of the conduits to the center line of the dam (to give support to the steadily increasing thickness of the superincumbent earth in the finished dam), the same

exterior form could only be used a few times—three times at Englewood and twice at Germantown.

The cost of the forms set in position for the first pouring was about 35c per cubic yard of the concrete placed against them, less than half what it

would have been for steel forms. By taking more time and building all of the upper portions with one set of forms the price could have been reduced below 25c per cubic yard. The necessity for pushing the work, however, did not permit this.

Earth Pressures in the Conservancy Dams

Experience has shown that the feature most needing to be watched in a hydraulic fill dam is the core, deposited by the water of the pool along the middle of the structure. Being somewhat plastic in the earlier stages of consolidation, it might, unless precautions were taken, give trouble through its tendency to thrust the dam shoulders aside and flatten out, as explained later. This tendency is increased if the core is built very thick and the shoulders proportionately thin. In the Conservancy dams, therefore, the core thickness is carefully restricted.

The flattening tendency is due to sidewise pressure in the material of the core, resulting from its plasticity. If a standpipe 1000 feet high were filled with moist earth, and an opening made in the side of it near the bottom, there can be no doubt that the contents would "squash" out through the opening, flowing like molasses under the pressure due to the superincumbent weight of its own mass. This sidewise flow indicates a sidewise pressure; is in fact the proof of it.

Now at the bottom of an earth dam, in the somewhat plastic materials of the core, the same sidewise pressure exists, tending to make the dam "squash" out at the base, just as a barrel of cold asphalt, with the hoops knocked off, will slowly flatten. As time goes on, the core slowly stiffens and consolidates. At all times the sidewise thrust is counterbalanced by the resistance of the upper and lower shoulders of the dam, built of gravel and sand, which act as powerful and massive buttresses preventing any possibility of movement.

The period requiring most watchfulness is naturally during and immediately following construction, when the core is most plastic, after deposition from the water of the pool. What needs to be known is the intensity of the earth pressure in the core interior, which measures in turn the side thrust, the tendency to flatten. Few measurements of this pressure have hitherto been made, and it was determined that in the Conservancy dams this lack should be remedied.

The central feature of the measuring apparatus is the "pressure cell," buried in the earth of the core at the point where the determination of pres-

sure is desired. The indicating devices are at the top of the dam, over the cell, and connected with it by small gas pipes which transmit the pressure, and by electric wires inside the pipes. The cell is a flat, hollow disc, one side of which is formed by a metallic diaphragm which receives the earth pressure. This pressure is balanced by air pressure pumped into the cell interior by a pump at the top through the pipes, the air pressure being measured by an ordinary gage. The earth pressure thus registers as directly on the air gage as the steam pressure in a boiler registers on a steam gage, except that the connecting pipe in the first case is longer. The pressure cell, buried in the dam, is virtually a diaphragm-balance, equilibrium of which is indicated by the breaking of an electrical contact carried by the center of the diaphragm, adjusted to happen just when the air pressure from the pump equals the earth pressure. An electric indicator at the top of the dam, connected with the contact point through the pipe wires, shows when the balance has been established. The air gage is read at this instant. By increasing the length of the pipes, as the dam is built up, such a cell may be made to give the pressures at any depth desired.

To make such a study complete, the pressures at all depths in the core need to be known. To secure these, cells are buried at regular intervals as the

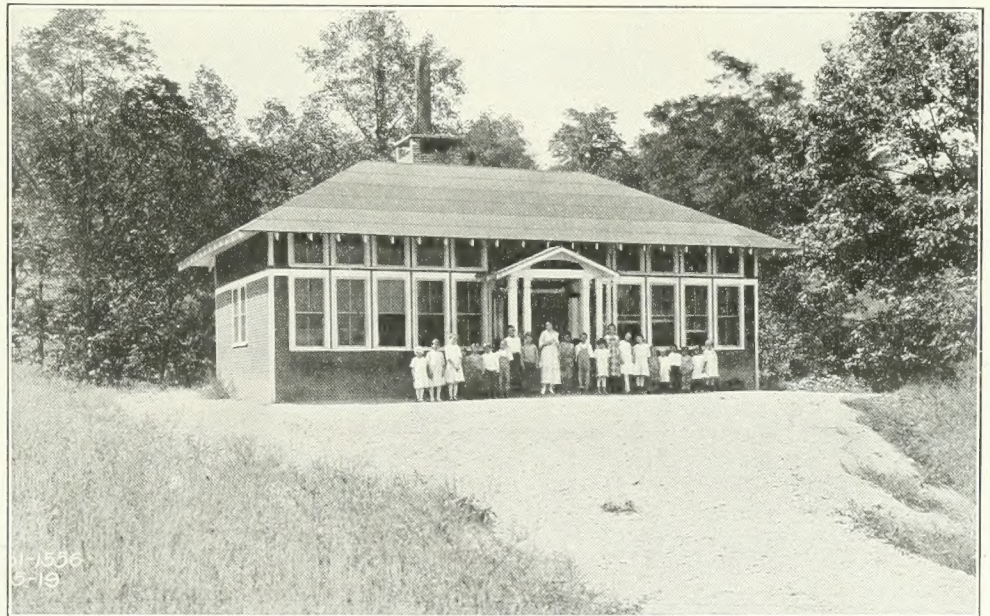


FIG. 38—CONSERVANCY SCHOOL AT GERMANTOWN

The school is pleasantly located in the edge of the woods on the hill just above and overlooking the camp. It is attractively furnished within, including a piano and a library supplied by the Germantown Camp Association. The work includes Domestic Science and Manual Training. Graduates receive the regular Ohio Eighth Grade Certificates, admitting them into any high school.

dam rises, and readings taken on all the cells. Thus a complete record will be made, giving the conditions as to pressure at all depths in the dam, and covering the entire period of construction, and also following construction. With this information at hand, as the work progresses, any corrections in the design or the construction methods can be made which may be advisable.

At the Germantown dam, the cells are suspended from wooden towers which are built up as the dam rises in height. Three of these towers are shown in figure 29, their relation to the center line of the dam being indicated by the center line trench in the hillslope beyond them. Three sets of cells are being used here to investigate the relation of pressures at the center and near the edges of the core. Similar cells will be placed in the core at all the other dams. Details regarding this work will appear later.

Elephants in the Miami Valley

By Professor August F. Foerste
Steele High School, Dayton, Ohio.

An interesting elephant tooth was found in Hamilton, Ohio, while digging a deep sewer trench, three blocks north of the court house. Three species of elephants formerly lived in the Miami valley, called the mastodon, the hairy mammoth, and the Columbian mammoth. All three ranged over wide areas on the North American continent. A fourth species, the royal mammoth, has been found only in the region of the Great Plains, from Iowa southwestward. The Hamilton tooth belonged to a hairy mammoth. It was the second tooth from the rear, in the lower jaw, on the right side, and the mammoth it came from was old. That the tooth belonged to one of the mammoths is indicated by numerous flat lozenge-shaped plates of enamel visible on the grinding surface of the tooth. That it belonged to the hairy mammoth is indicated by the closeness of the arrangement of these plates and the slightness of their curvature from right to left across the tooth. That it was a lower tooth is indicated by the concave curvature of the grinding surface. That it was the second tooth from the rear of the jaw is indicated by the fact that the number of enamel plates is 16. The rear tooth usually has 24 enamel plates, and the third from the front usually has 12 or 13 plates. The narrow end of the tooth is its front end. Its curvature to the left indicates that the tooth came from the right jaw. That the animal was old is indicated by the fact that the tooth is worn down at its front end almost to the roots.

The hairy mammoth is the best known fossil elephant. Its remains are found in Ireland and England, thence across northern Europe and Asia to Alaska, and across northern North America to the Atlantic ocean. It thus overran the entire land area of the northern hemisphere in the present arctic and temperate regions. It lived only in cold climates, during the glacial period, when the northern part of North America was covered largely with ice. To protect it against cold it was covered with a dense coat of wooly hair, the hairs two inches long. In addition to this wool there were coarse, long, stiff hairs, under the chin, on the shoulders and thighs, and under the belly, sometimes 20 inches long. Specimens of this elephant have been found encased in the ice of northern Siberia, with the meat

still fresh enough to be eaten by dogs. Parts of bodies, including flesh, skin, and hair, have been found in Alaska, but no complete specimens. So much is known about fossil elephants that large books could be written on this subject. For the present it will be sufficient to state that the Hamilton tooth came from the most common of all fossil elephants: that this species of elephant lived on the North American continent probably half a million years ago, and that it has become extinct only recently. Possibly some of the early Indians saw these elephants alive. Pipes curved into the form of elephants are known, but their genuineness as Indian relics is in doubt.

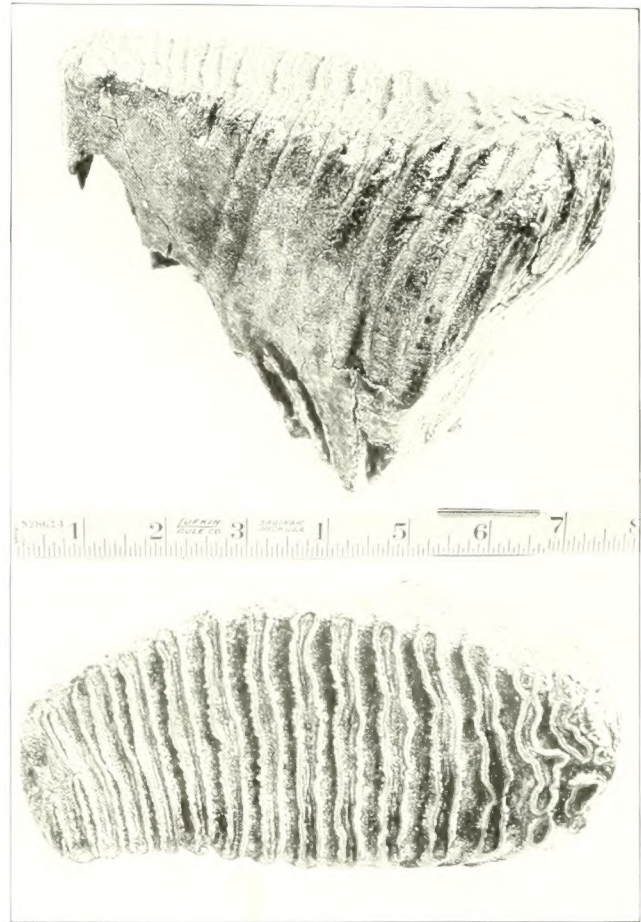


FIG. 39—TOOTH OF HAIRY MAMMOTH

The picture shows the tooth a little less than one-half of the actual size. (The rule seen is divided into inches.) It is from the right lower jaw, second tooth from the rear. The top view is shown below; the side view (as seen from inside, not outside of the animal's mouth) is shown above, the front end of the tooth, as it sets in the jaw, being at the left in the picture. Being found by itself, imbedded in gravel some distance below the surface, it seems probable this tooth was brought down from the north by a glacier. It is the actual tooth, not a petrification. On exposure to the air, it began slowly to crack and decompose, and had to be shellaced to preserve it. The cracks show plainly in the picture.

Visiting Chinese Engineers

Mention has been made before of the not infrequent visits to the Conservancy District of engineers from foreign countries who are interested in the problem of flood prevention. Among recent visitors are two young Chinese engineers who have

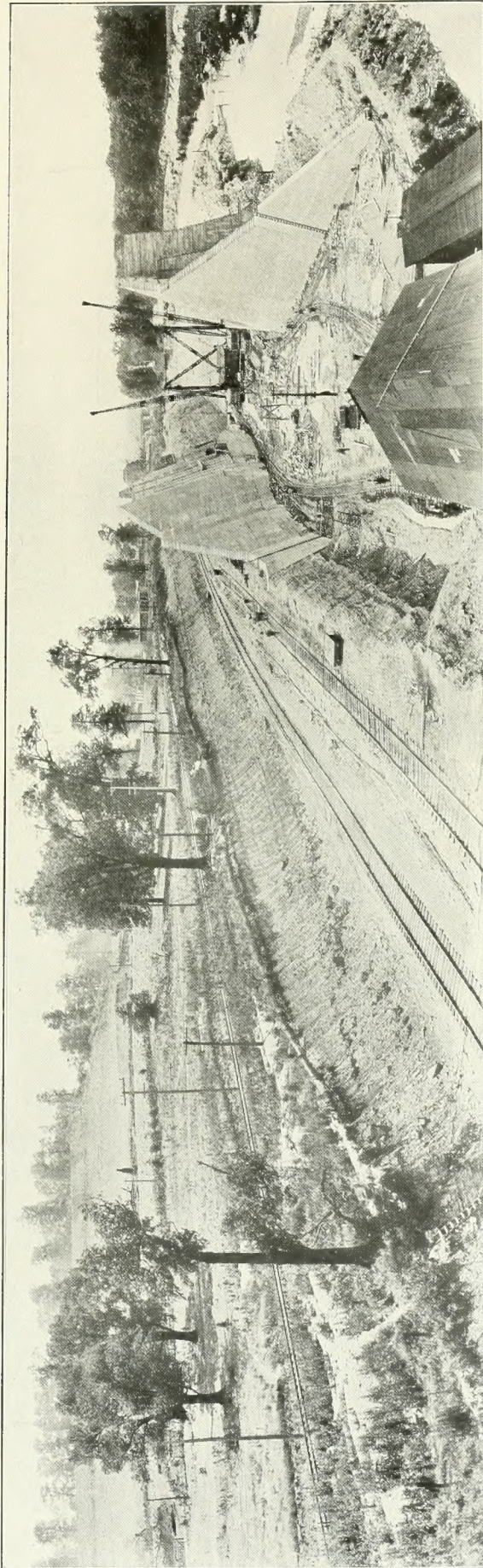


FIG. 40—PANORAMA SHOWING RELATION OF HUFFMAN OUTLET WORKS TO THE RAILWAY RELOCATION

been studying in this country and who are about to go back to their own country for service on what is probably its most important engineering project, the reconstruction of the Grand Canal. This canal is the longest, the oldest, and in future will probably be the most important in the world. It is over a thousand miles long and dates back 2500 years. It is a coastwise canal cutting across the Yangste Kiang and Hwang Ho rivers and is therefore subject to extensive overflow. The problem of flood prevention thus becomes one of the most important in connection with the great project of canal improvement now about beginning. The Chinese engineers mentioned are Messrs. H. Tan and N. Z. Zee, both of whom came to us from study in American technical schools, the former from the Massachusetts Institute of Technology and the latter from Cornell University. Their work in China will be under the direction of Joseph Ripley, Chief Engineer, and John R. Freeman, Consulting Engineer, the latter of whom has also been a visitor to the Miami Valley project.

Railways and Outlet Works at Huffman

The view shown in figure 40 is the first we have been able to print showing relation of the dam construction at Huffman to the relocation of the railway lines made necessary at this point. The view is southwest across the end of the damsite from the top of the gravel washing plant. At the right are the concrete walls of the outlet structure, built to their full height. They occupy the old bed of Mad River which was diverted to permit them to be built. The left-hand wall occupies also in part the old right of way of the Big Four Railway, which also had to be moved to permit the outlet construction. The roadbed was moved, temporarily, to the position indicated by the second track to the left of the left wall. (The first track is a construction track). The track next the Big Four is the temporary location of the Ohio Electric, which also had to be moved, its old position being only a little to the left of the old track of the Big Four. The final position of the Big Four is indicated by the heavy cut at the extreme left, this distance representing the total shift necessary to get the railway off the damsite. The Erie, which is to be shifted from the other side of the valley, (a distance at this point of about 3200 feet), will run beside the Big Four in the same cut, the two being operated together as a double track system. The final location of the Ohio Electric will be just this side of the big cut (as seen in the picture). The top of the concrete walls marks the crest of the finished dam, which will run to the left from the top of the walls until it reaches the Ohio Electric. A levee will extend up the valley on each side of the steam railways, the north levee acting also for the electric road, as a railway embankment. Near the dam, the levees rise about 26' above the steam railway tracks. They will extend eastward from the end of the dam for a distance of about $1\frac{1}{2}$ miles. It would seem natural to lift all three railways to a level with the top of the dam, making the levees unnecessary, but the already established gradients for the steam traffic did not permit this. The steam railways run through the cut at the dam 21.5 feet below spillway level.

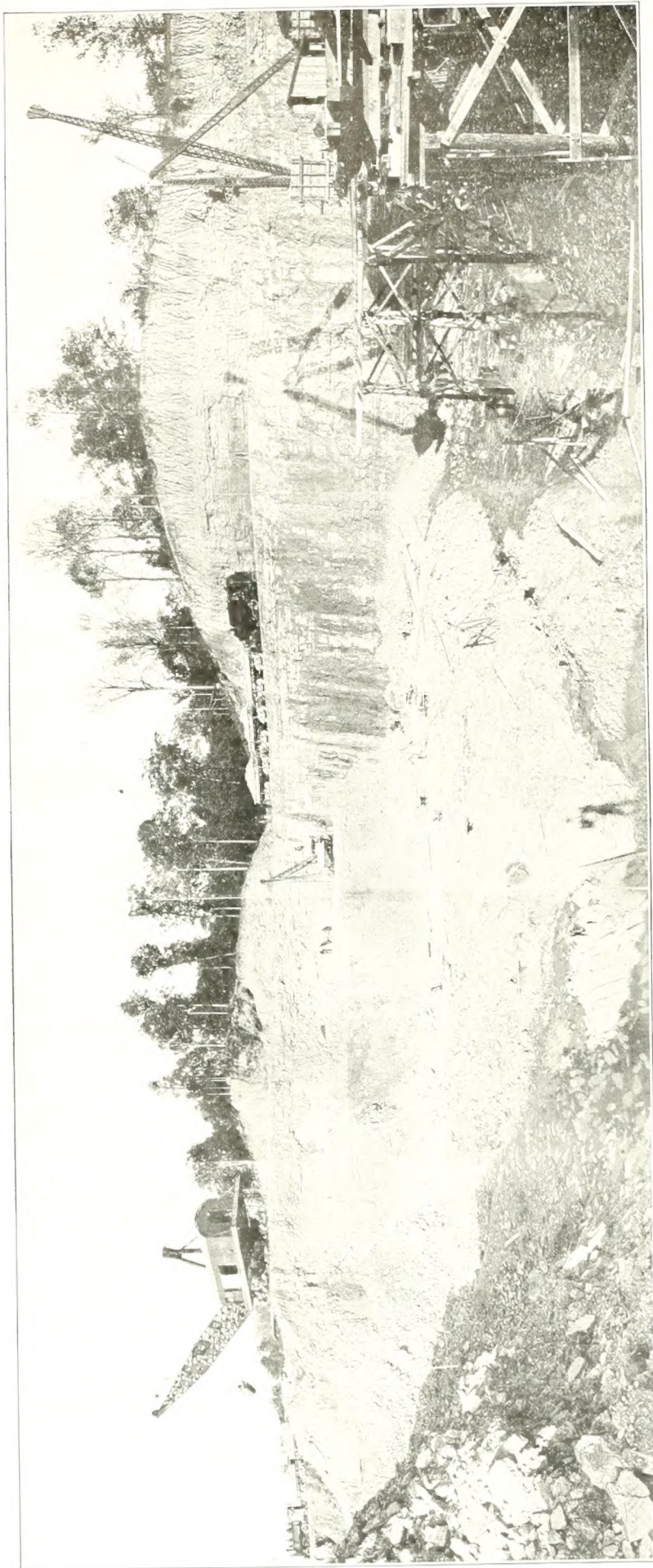


FIG. 41—EXCAVATION FOR OUTLET WORKS AT TAYLORSVILLE DAM SEPT. 24, 1919

The view is northeast and diagonally upstream, the river, just out of the picture to the left, here flowing nearly south. It shows the heaviest work of excavation at any of the dams, made necessary to provide space and foundation for the concrete structure which will carry the waters of the Miami River through the base of the dam after the latter is completed. Four tunnels, side by side, each 15 feet wide and 19 feet 2 inches high, and occupying a total space about 92 feet in width, will pierce the base of a heavy concrete cross wall located about where the dragline excavator stands in the picture. The water coming through these tunnels will flow down a concrete stairway about at the rock slope to the right and below the machine. This stairway will widen at the bottom into the hydraulic jump pool, 200 feet wide, in the middle foreground. The stilling pool, separated from the first by a high and heavy wall, will receive the water from it and pass it on to the river channel below (at the right in the picture). The flow provided for through the four tunnels, at maximum flood, (40% greater than in 1913) will be 55,000 cubic feet (about 1700 tons) per second.

The total excavation necessary will be about 845,000 cubic yards. 219,000 cubic yards of this is in rock, and is being dug by The Lidgerwood electric dragline excavator seen in the picture, equipped with 100-foot boom and $2\frac{1}{2}$ -yard bucket. The machine did the work standing on the rock shelf level it is seen to occupy (789 above

sea level). Its performance is believed to establish a record in respect of depth reached by the bucket, the lowest point of the excavation being 63 feet below the dragline mats, at elevation 726. It exceeds by 3 feet the performance of the machine at Hufman, mentioned in the Bulletin for June. The total depth of the cut, from the top of the earth slope at the right of the locomotive is 100 feet. The total length of the excavation is 2500 feet. Total depth of rock cut is 77 feet. The material is transported in 12-yard dump car trains, (two of which appear in the cut), drawn by 40-ton locomotives. The rock is used to build the upper toe of the dam; also as an extension to the lower toe, giving it weight and mass.

The rock was drilled and blasted before excavating. The heavy drilling was done by Cyclone drills like the one seen in the angle of the excavation. Ring bolts were fixed to the four corners of the drill frame and by means of four hooks and cables, which could be attached to the dragline bucket, the drills were hoisted into the air by the excavator and set wherever they were wanted, either on the upper shelf or below. Big blocks left by the shooting of the larger drill holes, and the faces and corners of the excavation, were finished up by air and Jap drills, some of which are seen at work at the left of the Cyclone drill.

The timbers at the right are the trestles supporting the two stiff-leg derricks which will handle the concrete used in building the outlet structure. One of these derricks is seen above, already erected. The concreting is now about to begin.